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September 22, 1998

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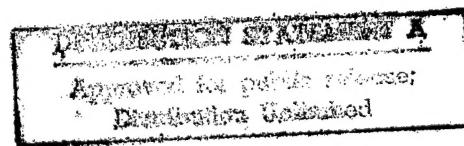
SUBJECT: Final Technical Report
ONR Award No. N00014-96-1-0041
PI: Dr. Thomas C. Lippmann

Enclosed for your records is the final technical report for the above referenced grant.

Sincerely,

A handwritten signature in black ink, appearing to read "Ann F. Dunbar".

Ann F. Dunbar
Contract & Grant Assistant
SIO, UCSD



Cc: Ms. Nancy Wilson
Dr. Thomas C. Lippmann

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13. ABSTRACT (Maximum 200 words) This grant consisted of two components, development of new instruments followed by three field investigations of the dynamics of the wave surface and bottom boundary layers in shallow nearshore waters. Standard (daytime) and intensified (night-time) video systems were developed and tested in the field experiments, and were used to measure the temporal and spatial variability in wave breaking occurrences on both land atop towers and at sea aboard ships. Video data obtained coincident with in situ pressure, bi-directional velocity, turbulence, and void fraction were used to calibrate new models for the transformation of wave energy across the surf zone, the forcing of nearshore circulation patterns, and characteristics of breaking waves including turbulence and bubble injection into the water column. Methods for measuring wave breaking on the continental shelf from shipboard video observations were developed in a series of cruises, and used to quantify whitecapping events in relation to sea and swell in the vicinity of a directional wavewaverider buoy.			
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Summary

This grant consisted of two components, development of new instruments followed by three field investigations of the dynamics of the wave surface and bottom boundary layers in shallow nearshore waters. The research grant was initiated at the Naval Postgraduate School with co-principal investigators Dr.'s E. B. Thornton, T. P. Stanton, and T. C. Lippmann. The summary which follows focuses on results contributed by Dr. Lippmann after his subsequent move to Scripps Institution of Oceanography in the second year of the initial three year grant duration.

A primary result of the instrumentation phase was the development of video image processing methods for quantifying the spatial and temporal variation of depth-limited wave breaking in the surf zone and steepness-limited whitecapping in intermediate and deep water. Both daylight and intensified nighttime video camera systems were developed which can be used to measure the location and time of individual wave breaking events that occur over several hundred meters both across-shore and along the coastline. These remotely controlled systems (via fiber-optic linkages) could be deployed under adverse weather conditions and continuously for several months. The time-synchronization of the video frames from multiple cameras can also be used for stereo-graphic analysis of wave breaking data. The statistics of wave breaking distributions obtained from a series of video cameras are used to calibrate new models for the transformation of wave heights across the surf zone, and quantified spatial forcing patterns for nearshore circulation that was not previously well understood. Methods for measuring whitecapping distributions were developed over several iterations and multiple field deployments, and resulted in a field tested method for quantifying the occurrence of whitecapping events in relation to synchronized observations of the sea-swell waves in the vicinity of a wave buoy.

The video systems and several other instruments developed as part of this grant by the co-PI's at the Naval Postgraduate School, were deployed for several weeks on a low-sloping beach in Monterey Bay in the winter and spring of 1995. The data showed that the spatial patterns of wave breaking significantly modified the previously modeled forcing distribution, and subsequently led to improved comparisons between modeled and observed set-up distributions across the surf zone, vertically varying undertow profiles, and bubble injections into the water column. New energy balance models for the spatial variation of wave breaking were verified with arrays of pressure data that measured wave height and nonlinear properties of the wave field (including wave asymmetries and skewness). These systems were deployed again for several months in the Fall of 1997 at Duck, NC, as part of the SandyDuck experiment. These data are being used to quantify the long temporal and large spatial variation of wave breaking patterns, and to compare the wave-driven forcing to collaborative observations of nearshore circulation, low-frequency infragravity motions, and suspended sediment concentration. As part of ongoing research, these results will be placed in context with the variation of bottom roughness and larger scale bathymetric features measured by our co-PI's.

Publications

Referred Articles:

Lippmann, T. C., C. F., Jorgensen, and E. B. Thornton, Wave slopes and breaking distributions in the surf zone, *J. Geophys. Res.*, submitted.

Lippmann, T. C., and E. B. Thornton, The spatial distribution of wave breaking on a barred beach, *J. Geophys. Res.*, submitted.

Theses:

Jorgensen, C. F., Wave slopes and breaking distributions in the surf zone, M.S. Thesis, Naval Postgraduate School, Monterey, CA, pp. 64, 1996.

Tannahill, J. B., Bubble injection under breaking waves, M. S. Thesis, Naval Postgraduate School, Monterey, CA, pp. 56, 1996.

Morris, B. J., Set-up under a natural wave, M. S. Thesis, Naval Postgraduate School, Monterey, CA, pp. 51, 1997.

Abstracts for Presentations at National and International Meetings:

Jorgensen, C. F., E. B. Thornton, and T. C. Lippmann, Wave asymmetry and breaking distributions on barred profiles, Abstract OS21B-7, *Trans. Amer. Geophys. Union*, 76(46), F293, 1995.

Tannahill, J. F., E. B. Thornton, T. P. Stanton, and T. C. Lippmann, Bubble injection events measured under breaking waves, Abstract OS21A-11, *Trans. Amer. Geophys. Union*, 76(46), F293, 1995.

Morris, B. J., E. B. Thornton, and T. P. Stanton, Wave set-up measured in the field, Abstract OS21A-01, 76(46), F293, 1995.

Thornton, E. B., T. P. Stanton, J. F. Tannahill, and T. C. Lippmann, Anatomy of breaking waves measured in the field, *Coastal Dynamics '97*, Plymouth England, 1997.